

What is claimed:

1. Apparatus for mixing and dispensing a multi-component bone cement, comprising:

5 a housing forming a mixing chamber, the housing having respective proximal and distal openings in communication with the mixing chamber, at least a portion of the mixing chamber extending from the proximal opening having a substantially uniform cross-section;

10 a mixing assembly including a rod extending into the mixing chamber from the proximal housing opening, and a mixing element attached to the rod proximate a distal end of the rod, the mixing element of a type such that movement of the rod relative to the housing causes the mixing element to mix bone cement located in the mixing chamber; and

15 an dispensing piston having an outer periphery sized to substantially seal the proximal opening of the mixing chamber while allowing the piston to be moved distally through the mixing chamber, the piston having an opening through which the rod extends into the mixing chamber.

2. The assembly of claim 1, wherein the dispensing piston is threadably engaged with an interior wall of the housing such that the piston is moved distally through the  
20 mixing chamber in a screw-like fashion by rotation of the rod relative to the housing.

3. The assembly of claim 2, at least one of the dispensing piston and interior housing wall having one or more helically winding, radially protruding threads designed to strip

from the respective piston or wall when pressure in the mixing chamber exceeds a certain amount.

4. The assembly of claim 1, further comprising an integrated cooling system for  
5 cooling the mixing chamber.

5. The assembly of claim 1, the mixing element comprising a perforated disc.

6. The assembly of claim 1, the mixing element comprising one or more rotatable  
10 blades.

7. The assembly of claim 1, the mixing assembly comprising a plurality of mixing  
elements attached to the rod proximate the rod distal end, each mixing element of a type  
such that movement of the rod relative to the housing causes the mixing element to mix  
15 bone cement components located in the mixing chamber.

8. The assembly of claim 7, wherein a first mixing element comprises a perforated  
disc and a second mixing element comprises a plurality of rotatable blades.

20 9. The assembly of claim 8, wherein the perforated disc is attached to the rod  
distally to the plurality of rotatable blades.

10. The assembly of claim 1, further comprising a sensor positioned at or near the distal housing opening to contact bone cement being dispensed there through, the sensor having an output signal.

5 11. The assembly of claim 10, wherein movement of the piston through the mixing chamber is controlled at least in part based on the sensor output signal.

12. The assembly of claim 10, wherein the sensor output signal is indicative of a pressure in the mixing chamber.

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13. The assembly of claim 10, wherein the sensor output signal is indicative of a temperature of the bone cement.

14. The assembly of claim 10, further comprising an output valve in fluid  
15 communication with the distal housing opening, the valve controllable based at least in part on the sensor output signal to divert bone cement being dispensed from the chamber into one of a patient delivery lumen and a shunt lumen.

15. The assembly of claim 1, further comprising an output valve in fluid  
20 communication with the distal housing opening, the valve controllable to divert bone cement being dispensed from the chamber into one of a patient delivery lumen and a shunt lumen.

16. The assembly of claim 1, further comprising a stop selectively positioned on the rod for engaging and moving the piston as the rod is moved distally through the mixing chamber.

5 17. The assembly of claim 16, the stop comprising an elastic ring that forms an interference fit around the rod.

18. The assembly of claim 16, the stop comprising a locking member that may be fixed to the rod with a screw.

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19. The assembly of claim 1, further comprising a barrier dividing the chamber into first and second isolated sections, the first section containing a liquid bone cement component, and the second section containing a solid bone cement component, the barrier of a type that may be broken upon the application of a sufficient force.

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20. The assembly of claim 19, wherein one of the liquid and solid components is sealed under vacuum in the respective mixing chamber section.

21. The assembly of claim 1, further comprising a patient delivery tube in fluid  
20 communication with the mixing chamber, the patient delivery tube being permanently fixed to the housing.

22. The assembly of claim 21, wherein the housing and patient delivery tube are formed as a single body structure.

23. The assembly of claim 1, further comprising a patient delivery tube in fluid  
5 communication with the mixing chamber, and an integrated cooling system for cooling one or both of the mixing chamber and patient delivery tube.

24. Apparatus for mixing and dispensing a multi-component bone cement, comprising:

10 a first body forming a delivery chamber, the first body having respective proximal and distal openings in communication with the delivery chamber, at least a portion of the delivery chamber extending from the proximal opening having a substantially uniform cross-section;

a second body connectable to the first body, the second body forming a mixing  
15 chamber;

an intra-chamber valve for selectably placing the mixing chamber in communication with the delivery chamber when the second body is connected to the first body; and

a dispensing assembly including a dispensing piston attached to a distal facing  
20 end of a dispensing rod extending into the delivery chamber through the proximal opening, the dispensing piston having an outer periphery sized to substantially seal the proximal opening of the delivery chamber, while allowing the dispensing piston to be

moved distally through the delivery chamber by movement of the dispensing rod relative to the first body.

25. The assembly of claim 24, wherein the dispensing piston is threadably engaged  
5 with an interior wall of the first body such that the piston is moved distally through the delivery chamber in a screw-like fashion by rotation of the dispensing rod relative to the first body.

26. The assembly of claim 25, at least one of the dispensing piston and interior first  
10 body wall having one or more helically winding, radially protruding threads designed to strip from the respective piston or wall when pressure in the delivery chamber exceeds a certain amount.

27. The assembly of claim 24, further comprising an integrated cooling system for  
15 cooling the mixing chamber.

28. The assembly of claim 24, the second body having an opening for accessing the mixing chamber

20 29. The assembly of claim 28, the second body opening comprising a sealing membrane that may be pierced by an injection needle.

30. The assembly of claim 29, the mixing chamber being filled with solid components of a bone cement.

31. The assembly of claim 28, further comprising a mixing cartridge sized to fit into the mixing chamber through the second body opening, the cartridge having a sealable opening positioned to be in communication with the intra-chamber valve when the cartridge is placed in the mixing chamber and the second body is attached to the first body.

32. The assembly of claim 24, further comprising a mixing assembly including a mixing rod having a distal end extending into the mixing chamber, and a mixing element attached to the mixing rod distal end, the mixing element of a type such that movement of the mixing rod relative to the second body causes the mixing element to mix bone cement located in the mixing chamber.

33. The assembly of claim 32, the mixing element comprising a perforated disc.

34. The assembly of claim 32, the mixing element comprising one or more rotatable blades.

35. The assembly of claim 24, further comprising a sensor positioned at or near the distal opening of the first body to contact bone cement being dispensed there through, the sensor having an output signal.

36. The assembly of claim 35, wherein movement of the dispensing piston through the delivery chamber is controlled at least in part based on the sensor output signal.

5 37. The assembly of claim 35, wherein the sensor output signal is indicative of a pressure in the delivery chamber.

38. The assembly of claim 35, wherein the sensor output signal is indicative of a temperature of the bone cement.

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39. The assembly of claim 38, further comprising an output valve in fluid communication with the distal opening of the first body, the output valve controllable based at least in part on the sensor output signal to divert bone cement being dispensed from the delivery chamber into one of a patient delivery lumen and a shunt lumen.

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40. The assembly of claim 24, further comprising an output valve in fluid communication with the distal opening of the first body, the output valve controllable to divert bone cement being dispensed from the delivery chamber into one of a patient delivery lumen and a shunt lumen.

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41. The assembly of claim 24, further comprising a barrier dividing the chamber into first and second isolated sections, the first section containing a liquid bone cement

component, and the second section containing a solid bone cement component, the barrier of a type that may be broken upon the application of a sufficient force.

42. The assembly of claim 24, further comprising a patient delivery tube in fluid  
5 communication with the delivery chamber, the patient delivery tube being permanently fixed to the first body.

43. The assembly of claim 42, wherein the first body and patient delivery tube are formed as a single body structure.

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44. The assembly of claim 24, further comprising a patient delivery tube in fluid communication with the delivery chamber, and an integrated cooling system for cooling one or both of the delivery chamber and patient delivery tube.

15 45. Apparatus for mixing and dispensing a multi-component bone cement, comprising:

a first body forming a delivery chamber;

a second body connectable to the first body, the second body forming a mixing chamber, the second body having a proximal opening in communication with the mixing  
20 chamber, at least a portion of the delivery chamber extending from the proximal opening having a substantially uniform cross-section;

an intra-chamber valve for selectably placing the mixing chamber in communication with the delivery chamber when the second body is connected to the first body; and

a mixing assembly, the mixing assembly including

5 a mixing rod having a distal end extending into the mixing chamber,

a mixing element attached to the mixing rod distal end, and

a mixing chamber ejection piston having an outer periphery sized to substantially seal the proximal opening of the mixing chamber while allowing the piston to be moved distally through the mixing chamber, the piston having an opening through which the rod  
10 extends.

46. The assembly of claim 45, further comprising a stop selectively positioned on the mixing rod for engaging and moving the mixing chamber ejection piston as the mixing rod is moved distally through the mixing chamber.

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47. The assembly of claim 46, the stop comprising an elastic ring that forms an interference fit around the mixing rod.

48. The assembly of claim 45, the stop comprising a locking member that may be  
20 fixed on the mixing rod with a screw.